20398
Wax

Packet Radio Temporary Note #85
NIC # 20398

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Design Suggestions

I would like to offer four suggestions for design of the Packet Radio Network:

1.) Fabricate terminals, repeaters, and stations by providing taps on each device for a 100 ohm cable (terminated at both ends) to run through. Then each device may transmit and receive 100K baud digital signals at baseband on the shared cable, bypassing the RF, modulator, SAWD, and detector sections of each device.

This arrangement is inexpensive (cable driver, receiver, some steering logic) but serves two important functions: first, an arbitrary number and mix of stations, repeaters, and terminals can be laced onto one cable on the workbench for the second stage of checkout: packet collision but no propagation problems.

Secondly, this arrangement can be used in the final packet radio network to concentrate all the terminals in an office building via one coax to a radio repeater on the roof, or to concentrate all the sensors and effectors in a vehicle to one radio repeater.

2.) Assuming that repeaters are located at an elevation of several hundred feet in order to obtain a repeater-terminal range of several miles, the repeater-repeater gain for the same range will be around 20 Db greater than the repeater-terminal gain; this difference arises from the additional 7.5 Db gain of the repeater antenna and from the additional altitude. This means that any repeater broadcasting to its terminals will interfere with store- and-forward operation of dozens of surrounding repeaters.

The solution is to "detune" the repeater-repeater channel to cause a deliberate 20 Db gain loss, equalizing the repeater-repeater and repeater-terminal gain for the same range. This may be done by selecting two sequencies A and B which have an impulsive cross-correlation peak 20 Db below their autocorrelation peaks. The terminals and station transmit on sequency A and receive on sequency B, while repeaters transmit on B and receive on A. The repeater-station and repeater-terminal channels have full gain, but the repeater-repeater channels have been "detuned" to cause an additional 20 Db loss. With this arrangement, a repeater should only interfere with its closest neighbors.

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3.) The simple scheme of store-and-forward hop acknowledge by overhearing the next rebroadcast permits even a single stream of traffic to interfere with itself.

For simplicity, each can only hear its immediate neighbors. During the first time interval, a packet goes from A to B. During the second, the packet goes from B to C and is overheard by A as a hop acknowledgement. During the third interval, A sends a second packet to B while the first packet is forwarded from C to D. Unfortunately, B receives the new packet from A at the same time he is listening to the C-D broadcast for hop acknowledgement. This packet collision will force eventual retransmission of the first packet from B to C, and the second packet from A to B. Throughput will be relatively low because, even in the best of circumstances, a data stream interferes with itself. The solution is simple: a repeater, station, or terminal should not transmit another packet until the previous one has travelled out of earshot. This requires listening to successive retransmissions of a packet through the chain of n repeaters that are within earshot, until a packet interval has elapsed without hearing the packet again. At that time, it is safe to transmit the next packet without fear of interfering with the previous one. In an area served by a single station, use of this algorithm assures that there is no interference between any outgoing packets, which constitute about 90% of the traffic. This smooth peristalsis thus provides very efficient use of the radio channel.

4.) There is a bottleneck in communication between the station and the first level of repeaters because the highest level of traffic (and interference) in the network is located here.

One possible solution here is space diversity. Use a half dozen pencil beams from the station out to a set of first-level repeaters on the periphery of the network. This is possible because (see suggestion 2) the station-repeater gain is 20 Db greater than the repeater-repeater gain, and the pencil beams enhance this further. The use of separate electronics on the six station antennas prevents any interference between these channels at the station, and the wide separation of the first- level repeaters prevents any interference between the channels at that end. This should increase the peak capacity of the Packet Radio Network by a factor of 6.